

# Study to Evaluate the Price and Markets for Residual Solids from a Dairy Cow Manure Anaerobic Digester

## Final Report



*A Report Prepared for*



**King County**

Department of  
Natural Resources and Parks

**Solid Waste Division**

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## **1 Introduction**

The goal of this project was to evaluate the potential markets and market price for the residual solids from a dairy cow manure thermophilic anaerobic digester as proposed by the Feasibility Study (FS) performed for King County (EnRRG, 2003) in order to develop confidence in the assumption that the material could be sold for a minimum of \$20 per ton.

The project required familiarity with the residual solids assessment in the feasibility study; an analysis of the nutrient content, pathogen & odor characteristics, and other contaminants that might be present; and an assessment of the expected market price for the solids including discussion of the factors that could add or reduce the value of the product.

Terre-Source<sub>LLC</sub>, in association with CH2M HILL and Composting Waste Management Consultants (CWMC) were contracted to accomplish these goals through the following tasks:

- review of the solids related portion of the Feasibility Study (FS) report;
- research to identify digesters currently operating under similar parameters as those proposed in the FS in order to obtain a sample of such residual solids for chemical and biological analysis and a growth study; and evaluation of the laboratory and literature data to determine expected characteristics of the residual product
- performance of a market study to evaluate the most likely potential market and the probable value of the solids in that market.

These tasks are part of King County's due diligence evaluation of the FS, and involve identifying weaknesses in the assumptions in the FS related to the solids production and sales. The overall concept of this project to involve all the various interests in creating a centralized anaerobic digester to assist dairies on the Enumclaw plateau, to recover methane for energy, to recycle organic wastes, to protect water quality in the Green River watershed, to protect air quality, and to reduce greenhouse gas emissions, is inspiring and an excellent approach. This team has complete confidence that it can work.

This report describes the work and findings from each task in sections 2 through 4. Section 5 summarizes the conclusions and the implications of the results of this study and identifies areas that should be researched in more detail. Cited references are summarized in Section 6. Appendices A through E provide details about specific topics as follows:

Appendix A: Anaerobic Digester Operations & Solids Characteristics Table

Appendix B: Laboratory Data

Appendix C: Growth Trial Photos

Appendix D: Notes from Market Contacts

Appendix E: National Organic Program and WSDA Organic Certification information

☞ The task of this report was to evaluate assumptions made in the FS about the solids generated in the proposed anaerobic digestion process. To draw attention to issues that may require revision, when a finding is made that conflicts with the FS in this report a flag is added to the left of that paragraph and the difference is discussed with potential cost implications. These flagged items are summarized in Section 5 of this report.

## **1.1 Background**

King County has grown dramatically over the past 10 years pushing property values up and urban issues out further and further into areas traditionally utilized for farming. Agriculture, although threatened, is valued in King County and a number of programs have been put in place to protect farming (such as the Farmland Preservation Program, Puget Sound Fresh, FarmLinks, Farm/Forest Initiative, and agricultural zoning). Nutrient management is also becoming a much larger issue for livestock producers such as the dairymen in the Enumclaw area. Odor, run off contributions to water quality, and limitations to herd size proscribed by NRCS nutrient management plans are limiting these dairies' ability to predict their economic future in the area.

King County is considering anaerobic digestion (AD) technology and subsequent solids processing to help dairy farmers survive manure management challenges that are limiting growth and economic vitality of these farms. The feasibility study (FS) recommended a centralized complete mix, thermophilic process to produce methane for energy, liquid effluent, and a high quality residual solids product. The economic feasibility of the project relies greatly upon sales of the solids to generate the largest portion of income for this project. Given this reliance, the characteristics and market price of the product are critical. This study evaluates available information about the potential nutrient content, bulk density, pathogen levels, product appeal, and regulatory requirements for this product. This information was used in a market study performed to investigate the mostly likely market and market price for the product and some of the factors that could impact its value.

## **2 Feasibility Study Review**

Historically anaerobic digestion projects have failed in implementation or operation due to high costs, design flaws, failure to find beneficial use for the liquid effluent, and failure to produce adequate income from the solid residual. Other practical issues of odor control, quality and consistency of the outputs, and the reliability of process equipment are significant for this project.

The review focuses on the factors and assumptions made with regard to the solids produced by the proposed facility. It also considers indirect issues that affect the sustainability of the conversion of solids in a reliable revenue stream.

### **2.1 Methodology for Review**

Key information from the FS has been selected to prove (or disprove) the conclusions of the document. The approach is to highlight key issues and values, and then compare it to the experience or opinion of others. Some general cross checking of calculations has also been done to insure the basic approach in the document is sound. Finally the proposed factors and assumptions are weighed against local conditions and history to insure they are realistic for King County.

### **2.2 Evaluation**

The FS relies upon the solids to generate the largest portion of income for this project through sales as fertilizer or soil amendment. Given this reliance, the economic viability of the project hinges on the quality and market price of the product. Several assumptions and projections were taken from the FS to help evaluate how realistic the report is in terms of long term success. Some key assumptions and projections are:

- The facility is expected to convert 252,000 tons per year of feedstock into 36,568 tons of "Solid Organic Fertilizer".
- This is a unit conversion rate or solids "yield" of 0.145 tons per input ton, assuming no additional water is added.
- The economic analysis is based on 8 percent solids in the feedstock.
- The capital costs allow \$1.2 million in capital cost (16 percent of project development costs) for solids handling.
- Unit processing costs of \$5 per ton of solids to prepare them for sale.
- The average unit revenue for the solids is assumed to be \$20 per ton.
- There is no allowance for sales and marketing expenses to promote and sell the residuals.

Each of these factors and assumptions has been considered and comparable figures from other projects have been sought wherever possible.

In an effort to fully understand the mass balance for the project a computation was made to approximate what the FS proposed, and to insure there were no fatal flaws with regard to input and output assumptions. Table 2.2-1, below, shows one possible set of numbers:

Table 2.2-1 Check of FS Solids Related Calculations					
Annual Basis	tons			tons	tons
Inputs	gross input	solids rate	moisture rate	Dry tons	Water tons
manure input	252,000	8.0%	92.0%	20,160	231,840
Recycle	-	0.0%	100.0%	-	-
Amendment	-	0.0%	100.0%	-	-
Subtotal	252,000	8.0%	92.0%	20,160	231,840
Process losses	dry tons	solids loss	moisture loss	Net dry tons	
manure input	20,160	50.0%		10,080	
Recycle	-	0.0%		-	
Amendment	-	0.0%		-	
Subtotal	20,160	10,080		10,080	
			205,920		
Target final values		28.0%	72.0%		
	wet tons	solids	moisture	Dry tons	
Expected output	36,000	28.0%	72.0%	10,080	
Computed net output		14%			
Computed process loss		86%			
Target recycle rate		0%			
Target product rate		100%			
Computed recycle	- tons				
Computed product	36,000 tons				

This table correlates reasonably well with the FS in that the projected solids produced are 36,600 tons and the liquid outputs (combined) are 208,500 tons (50,000,000 gallons). The comparable figures in the table above are 36,000 tons and 205,920 tons respectively. This helps validate the overall "mass balance" of the proposed project. It should be noted that about 10,100 tons per year are converted (lost) as gas through decomposition. The FS does not propose to add water, although that may be necessary to improve the physical operation of pumping and material handling or to prevent excessive concentrations of some constituent like ammonium that could affect the microbial communities responsible for digestion. If additional water were added it would increase the size of the digester(s) required.

Another recent digestion technology assessment was prepared by the Seattle Public Utilities for a proposed 51,000 tons per year (93,600 tons with makeup water) feedstock consisting of urban food waste. This report, while addressing a different feedstock, predicted a solids "yield" rate of 0.235 tons per input ton<sup>1</sup>.

<sup>1</sup> Seattle Public Utilities; Anaerobic Digestion of Source Separated Food Study; September, 2002; Seattle, Washington

Discussions with the operators of other thermophilic manure digesters suggest the optimum solids content for physical operation is between 6.5 and 7.0 percent. This of course will vary depending upon the concentration of soil and grass in the feedstock. It will also depend upon the design of the material handling equipment like pumps, heaters, and piping systems. Since the FS has proposed operating at 8 percent solids the project will have to carefully limit or minimize:

- Soil in the feedstock
- Low quality or under-powered mechanical equipment, and
- Piping systems that would collect solids.

Other facilities reported having problems with pumps and grinding equipment related to un-eaten grasses and fibrous bedding materials. This proposal intends to include sawdust and wood shavings bedding. The equipment will need to be designed to handle those types of materials.

Some other manure digestion facilities have reported problems with contaminants as well. One facility reported problems with straw plugging the equipment and various physical contaminants like plastic bags, vet gloves, needles, beverage containers, and twine<sup>2</sup>. Another reported chains, tools, rocks, sand, and minerals<sup>3</sup>. These can affect the quality of the solids product, as well as cause physical problems with the digesters.

The solids handling equipment is not well described so it is difficult to judge how adequate the \$1.2 million allowance is in the FS financial projection. The solids handling system is expected to handle the material for up to 60 days. This represents 10,000 to 12,000 cubic yards of piles onsite at any given time.

- ☞ At the very least the facility will need a medium sized front end loader (3 - 6 cubic yards bucket), a dewatering device, a trash screen, a biodrying (composting and drying simultaneously using forced air) system, and a storage area. This will require about 1 acre of pavement for 60 days of residence time. A low-cost system of this type can be found in Eugene, Oregon.
- ☞ This facility is composting and drying about 8,800 cubic yards continuously at a cost of \$10 - 15 per input ton. This is higher than the \$5 per ton solids handling cost allowed in the FS.

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<sup>2</sup> Terre-Source LLC; telephone interview; Inland Empire Utility Agency; October, 2003; Ontario, California

<sup>3</sup> Robert Foster; Anaerobic Digestion, Power, and Composting for Twenty One Years; WEF Agricultural Digester National Summit; June, 2003; Raleigh, NC



Similar composting/biodrying in Eugene, Oregon - each pile contains about 2,200 CY

### **2.3 General Feasibility Study Review Summary**

The capital and operating costs of the solids handling elements should be reviewed to insure the solids will be consistent, adequately aged, aerobic, low in ammonia odors, dry enough to handle easily, free of physical contaminants, and free of weed seeds.

✎ The 30 - 60 days for composting/biodrying allowed for in the FS appears adequate, but the seasonal demand for the product might require 6 to 9 months of storage. Storage for this length of time and quantity (which will vary depending upon moisture content) was not addressed in the FS. The volume of product this represents (assuming a well composted product at 40% total solids generated for 9 months at the rate predicted in the FS) would be about 13,500 tons. Assuming 1 ton is approximately 2 cubic yards – 27,000 cubic yards, stored in piles no higher than 12-feet would require a minimum area of about 2 acres depending upon configuration. This storage area should be designed to protect the solids from moisture accumulation during the rainy winter months. This could be accomplished by tarping and proper site grading. It is not clear whether the capital costs include enough money for pavement (including this extended solids storage) and the unit processing costs (\$5 per ton) as mentioned above, are assumed to be lower than comparable facilities with operating experience.

Based on experience with marketing in general and the compost market specifically, the average unit revenue for the product will only be achieved after an initial "discount period" and then a gradual increase in the unit pricing. This discount period is necessary to build label familiarity and confidence in the product performance. The product will have to be heavily discounted and/or be given away for trials. This is especially true for anaerobic digestion material that is even less understood in the market than compost. Gradually, as marketing and community outreach programs (which are necessary to eventually obtaining a premium price) build the product image, the pricing can be increased.

- ✎ How quickly the price can reach an “average unit revenue” is partially determined by the quality of the product, the responsiveness of the delivery system, and the effort of the marketing and sales staff. Some initial discount period should be applied to reflect the lower initial income when the project begins and the value of the product is unknown in the marketplace. A reasonable period, based on the King County yard waste recycling experience, would be five years. The FS assumes that \$20 per ton can be asked initially and does not include marketing expenses.
- ✎ At least one sales person should be included in the expenses for the project. The cost of labor, staff expenses, advertising, sampling, and solid product analytical work should be included in this activity.
- ✎ The FS does not appear to consider mass loss during the composting/biodrying process. Over the 60 day residence time there will be significant shrinkage. One computation assuming 5% loss of dry matter and moisture loss (from 72% to 45%) resulted in the 36,600 tons of solids becoming only about 18,000 tons of salable product.

Evaluation of the liquid fertilizer and high-quality water products have not been made in the review. They are beyond the scope of this evaluation.



### **3 Anaerobic Digestion Residual Characteristics**

The important characteristics for the proposed material vary depending upon the market being investigated. Topsoil blenders are more interested in the physical properties (particle size, odor, organic matter content) and whether the material would meet WSDOT specifications. Nurseries cared more about the nutrient content and salts, pH, and weed seed. The dairies were most concerned about pathogen content for using the material as animal bedding.

#### **3.1 Approach**

Investigation into the characteristics expected from the residual of an anaerobic digestion plant similar to that recommended by the FS consisted of the following steps:

- An internet and contact search for a similar anaerobic digester in operation in the United States (limited to the US because of reported differences in dairy management in other countries that could impact residual characteristics);
- An internet and literature search for reports containing characteristic data of thermophilic anaerobic residuals
- Collection and analysis of anaerobic digestion samples for nutrient content, physical parameters, pathogen content, plant germination and weed seed content
- Evaluation of results and compilation of estimated characteristics of residuals resulting from an anaerobic digester operating at thermophilic temperatures (at least 131°F) and using no polymers or other chemicals in the process.

#### **3.2 Thermophilic Anaerobic Digester Search & Evaluation**

Two facilities in the US were located which operated anaerobic digesters at thermophilic temperatures on dairy solids. The first was at Tinedale Farms in Wisconsin. The system installed there was a Temperature Phased Anaerobic Digester (TPAD) that began operation in spring 2001. This facility had numerous problems operating at thermophilic temperatures and had reportedly recently decided to run at mesophilic temperatures, abandoning the temperature phasing. The last time this facility had operated at thermophilic temperatures was June 2003 and therefore could not supply a residual sample for testing; however, their experiences were thought to provide useful information about potential issues to address.

The second facility operating at thermophilic temperatures is located in Ontario, California. This facility is a wastewater treatment plant that was retrofitted by CH2M HILL in 2001 to collect methane for energy from the anaerobic digesters. The retrofit enabled one of the 6 digesters to be utilized for dairy solids from farms in the surrounding Chino Valley. There are a number of similarities between the situation in Chino and that in King County. Ontario is a suburb of Los Angeles in which rising land values and pressures from urbanization present increasing challenges to both wastewater treatment facilities and the remaining farming enterprises. Odors, nutrient management, and restricted land availability for livestock management are important issues. We were able to obtain a sample of the digested solids as they emerged from the belt press for analysis.

In order to bracket the characteristics of the residuals, and because no other similar thermophilic ADs could be located, a sample was obtained from a dairy solids fed, mesophilic, anaerobic

digester near Salem, Oregon. This facility is located on a single dairy running 500 cows and has been operational since mid 2001.

There are numerous processes involved in production of an anaerobic digestion residual solid. Variation in any of these processes may change the characteristics of the resulting solid. The samples available for analysis and the time available for detailed evaluation were extremely limited for this study. We could not, for instance, find a digester that used the exact size or process that was recommended in the FS. Evaluation of the similarities and differences between the processes and feedstocks used at each of the digesters studied involved collection of information about the dairy practices, cattle feed, digestion plant operation and practices. These data were tabulated and are presented in Appendix A.

The contacts made for each of these operations were extremely helpful and many offered suggestions and information about problems they had encountered and how they had been overcome or not. Some of these issues are included in the table in Appendix A, others were discussed in the FS review section above. A thorough evaluation of all of the process information and lessons learned available is beyond the scope of this project, but would be worth exploring further in order to learn from those who have attempted similar processes.

The most critical differences between the plants which provided samples for analysis and the King County proposal are summarized in Table 3.2-1 and were considered when evaluating the laboratory results:

<b>Table 3.2-1</b>			
<b>Summary of Operational Similarities &amp; Differences</b>			
	<b>King County Proposal</b>	<b>Cal-Gon Dairies, OR</b>	<b>Chino RP-1, CA</b>
Size of facility	6000 cows	500 cows	3200 cows
Detention time	15 days	18 days	31 days
Temperature Regime	Thermophilic (135°F)	Mesophilic (95-100°F)	Thermophilic (127.5°F)
Use of polymers for thickening solids	No	No	Yes
Use of ferric chloride to “knock down” sulfides in digester	No	No	Yes
Bedding in feedstock	Yes – sawdust/wood shavings	Yes, wood shavings	No

### **3.2.1 Sample Collection & Handling**

The thermophilic residual sample was collected on 9-25-03, and was chilled and sent overnight to CWMC, where it was separated for transport to the chemical and biological laboratories and prepared for the growth trials. The sample collected for biological analysis was kept chilled until delivery to Microbial Matrix Systems, Inc. (MMSI) in Tangent, Oregon, on 9-29-03.

The mesophilic residual sample was taken from the screw press on 9-29-03 and kept chilled until delivery to MMSI laboratory later that morning. The samples for chemical analysis were sent standard 2-day delivery to Wallace Laboratories in El Segundo, California. The growth study was started on 9-30-03.

☞ Observations of the appearance of the samples were made by CWMC on receipt. The mesophilic solids resembles typical separated solids from a lagoon in appearance, though the particles are slightly more fibrous. Color is light golden brown. The thermophilic solids were thicker and dark in color with obvious lighter colored straw particles. The mesophilic sample had a “dairy barn” odor which lightened and subsided with age. The thermophilic sample was more permeating and odorous.

### **3.3 Laboratory Analyses & Growth Trials**

#### **3.3.1 Chemical Analyses**

Wallace Laboratories in El Segundo, California was contracted to perform their standard media/amendment analysis, ammonium nitrogen, total nitrogen and total carbon, organic matter and ash, and bulk density analyses. The laboratory report is presented in Appendix B.

#### **3.3.2 Biological Analyses**

Microbial Matrix Systems, Inc. in Tangent, Oregon was contracted to perform total coliform, E. coli, total fungi, and particle size analyses on each sample. Their laboratory report is presented in Appendix B.

#### **3.3.3 Growth Trials**

CWMC in Beaverton, Oregon performed growth trials to observe the performance of the residuals as a soil amendment with both peat and an inorganic sandy loam soil. An informal study of weed seed presence was included in the trials by looking for any germination other than the species planted.

CWMC started the growth study on 9-30-03 with plantings of beans in the AD residuals mixed with peat moss at varying percentages; radishes planted in the residuals mixed with sandy loam at varying percentages; and chives planted in the residuals mixed with peat at varying percentages.

Three species were planted in various planting media mixes. The thermophilic and mesophilic residuals, a local compost<sup>4</sup>, a local very aged compost (Humus<sup>5</sup>), and purchased peat moss<sup>6</sup> were mixed with different amounts of local sandy loam and planted with Radish seeds to determine germination and root development (5 seeds per pot). The percentages of each media in the sandy loam were: 100%, 75%, 50%, 33%, 25% and 15%. One pot was planted with 100% Sandy Loam<sup>7</sup>.

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<sup>4</sup> Moderately aged compost from Beaverton, OR local compost producer

<sup>5</sup> Extremely well aged compost from Beaverton, OR local compost producer

<sup>6</sup> Sunshine Canadian Sphagnum Peat Moss, bagged product purchased at Fred Meyer

<sup>7</sup> From Beaverton, OR local soil manufacturer and blender

Bean Seeds were used to determine clopyralid contamination, germination, root development, stock and foliar development (3 seeds per pot). The anaerobic digestion media and the composts were mixed with peat instead of sandy loam in this trial. The amounts of each media in the peat were: 100%, 75%, 50%, 33%, 25% and 15%. One pot was planted with 100% Sandy Loam and one with 100% peat moss.

Chive seeds were also planted to determine foliar development, root depth and development. The media were mixed with peat. However, 8 days of growth were insufficient for use of this trial.

Watering was performed at about 25 ml per pot initially and thereafter as needed. Watering needs were tracked based on observed dryness of soil. This allowed observations of the ability to determine the moisture retention/porosity of the media mixes soil and prevented over-watering of some plants because of higher moisture retention.

### **3.3.3.1 Growth Study Observations**

Observations of seed germination and measurements of plant growth were made daily from the third day after planting through the 8<sup>th</sup> day. On day 8 the plants were removed from the pots and the roots examined for length, branching, and general health and observations were made of the media mix. Germination and plant growth measurements are included in Appendix C.

In the bean trials, three bean seeds were planted in each pot with peat used to mix with the other fibers. The 8<sup>th</sup> day count of germination totals were higher for the mesophilic fiber mixed with peat. All three seeds germinated in all mixes except for the 100% thermophilic fiber treatment for a total of 16 of 18 seeds germinated. The compost was second with 15 of 18 seeds germinated; and the mesophilic and humus materials both had 14 of 18 seeds germinated.

For the radish trials 5 seeds per pot were planted with sandy loam used to mix with each tested fiber material. The 8<sup>th</sup> day count of total germination were 28 of 30 for the humus; 26 of 30 for the compost; 25 of 30 for the mesophilic fiber; 24 of 30 for the peat; and 23 of 30 for the mesophilic fiber.

The bean plant growth measurements on day 8 showed the differences in the amounts of fiber in the media mixes as well as the preferences for particular media. The following table gives the measurements of the tallest plant height and the average height of the three plants per pot.

<b>Growth Measurements - Beans - Oct 7, 2003</b> 3 seeds per pot Fibers mixed with Peat as shown Tallest / Average measurement						
% Media with Peat	Compost	Humus	Thermo-philic	Mesophilic	Sandy-loam	Peat
100%	0.25 / 0	0.25 / 0	0.25 / 0	0.25 / 0.1	4.75 / 3.0	3.5 / 2.0
75%	3.0 / 2.0	1.0 / .75	1.5 / 1.0	<b>6.5 / 3.0</b>	x	x
50%	<b>5.0 / 3.0</b>	2.5 / 2.0	4.5 / 3.0	<b>5.0 / 3.0</b>	x	x
33%	<b>7.0 / 7.0</b>	6.5 / 2.5	4.75 / 3.0	6.0 / 4.0	x	x
25%	<b>8.0 / 4.5</b>	6.75 / 4.25	6.0 / 3.5	7.5 / 3.0	x	x
15%	8.0 / 3.0	8.0 / 4.75	<b>8.0 / 5.0</b>	6.75 / 2.0	x	x
Shading indicates largest plants in that media (i.e. of the Thermophilic mixes the 15% mix performed the best) Bold text indicates largest plants at that concentration (i.e. at 15% of the mix the Thermophilic fiber outperformed the other materials)						

Both thermophilic and mesophilic anaerobic digestion fibers performed similarly to the compost, and humus, and out performed peat moss alone or sandy loam alone at some percentage. The thermophilic fibers performed best with the least amount of material (15%) in the mix; and at that mix rate slightly outperformed all of the other materials. The mesophilic sample performed best at 25% and 33% of the potting mix.

Observations of root, stock, and plant development were used during the market outreach study including:

- At lower percentages (from 15% to 25%) of the potting mix, the root and stock development of the digested fibers (thermophilic and mesophilic) performed similarly to compost and peat mixes, and in some cases out performed them.
- The digested fiber samples tended to maintain moisture longer than the compost or peat moss.

Since the materials equaled or exceeded the performance of the compost and peat mixes in this trial, at least on these materials, for this length of time, the high salts in both samples did not appear to cause harmful effects.

### 3.3.3.2 Weed Seed Observations

An informal weed seed trial was performed during growth trial simply by looking for any species that germinated besides the planted species. There were no weeds observed in any of the treatments during this growth trial. This is an inconclusive result, however, since there may have been no weed seeds in original materials, weeds may take longer than 8 days to germinate, or all of the treatments (including those of the compost and humus) effectively killed weed seeds.

Two sources regarding weed seeds contradicted each other although neither referred to thermophilic processing per se. Allan, et al. (2003) performed a weed seed study in which they placed bags of seeded feedstock into a mesophilic digester and then evaluated the weed growth.

They found very little reduction in seed viability after digestion. On the other hand, Sullivan, J. (2002) noted the “partial to complete destruction of weed seeds” during anaerobic digestion.

### **3.4 Thermophilic Dairy Residual Characteristics Evaluation**

#### **3.4.1 Physical Characteristics**

The physical or sensory characteristics evaluated that were thought to impact the marketability of the product included moisture content, bulk density, particle size, odor, and appearance. The laboratory and observational results were evaluated relative to the processes used to produce these samples versus those proposed in the FS. Table 3.4-1 summarizes the parameter values selected for the proposed material. The thermophilic material was more dense than mesophilic and described as “cakier” when fresh perhaps due to additional digestion time or polymer addition.

☞ The odor of both materials was described above and conflicts with other reports. Odor may be partially controlled by processing which may explain the differences. The FS claims the material will have no odor. John Katers of the University of Wisconsin at Green Bay was involved with the Tinedale Farms Temperature Phased Anaerobic Digester. He observed that the solids produced by their thermophilic process were “very strong smelling” and generally worse than those produced during the mesophilic phases.

#### **3.4.2 Nutrient and Fertility Characteristics**

Nutrient analyses of the two samples indicated that the thermophilic sample was higher in nutrients across the board. Nitrogen content of the thermophilic sample was 2.6% compared with 1.25% in the mesophilic sample. It is not known whether this is due to greater nitrogen retention in the process due to polymer addition, increased breakdown of total solids thus concentrating the nutrients, differences in feedstocks, or other addition in the process.

Salts as represented by electrical conductivity ( $EC_e$ ) were high in both samples, but higher in the thermophilic sample. Some portion or all of the high salts in that sample could be attributed to the addition of ferric chloride in the digester to “knock down” the sulfides produced. This would also explain the much higher iron, chloride, and potentially sulfur contents in the thermophilic sample.

The Carbon to Nitrogen ratio is often considered in a compost to indicate whether it would be likely to add or remove nitrogen from the soil in which it is mixed. Ideal ranges are around 20:1 depending upon the use and crop.

Ammonium as N was very high in both samples, while nitrate as N was, predictably for an anaerobic process, negligible. Ammonium can be toxic to plants at too high concentrations. Nitrate is the preferred form for plants. This is another reason that composting would improve the value of the product, as the aerobic process promotes the conversion of ammonium to nitrates, although some nitrogen can be lost through volatilization of ammonia.

<b>Table 3.4-1</b> <b>Summary of Evaluated Characteristics of</b> <b>Thermophilic Anaerobic Digestion Solids</b>		
<b>Parameter</b>	<b>Estimated Value</b>	<b>Comments</b>
Total Solids	25%	Per lab results
Bulk Density	30-40 #/cubic foot (~1000 #/cubic yard)	Per lab results
Appearance	Fibrous, dark brown	Composting will positively impact the appearance of this material
Odor	Strong	Odor decreases with time and aeration. Composting will dramatically improve this parameter.
Particle size	100% < 9.5mm ~50% < 2mm	Awaiting lab results for mesophilic sample. It is expected to be similarly fine grained.
pH	~8-8.5	Per lab results
Total N	~2 %	Revised down due to potential for 2.6% from thermophilic sample to have been influenced by polymer sorption
Phosphorus	<0.1%	Per lab results
K - potassium	~0.50%	Per lab results
calcium	~0.2%	Per lab results
Organic Matter	~80%	Per lab results
C:N	16-20	Per lab results
salts - ECe	~2.4 mmhos/cm	Per mesophilic lab results because of known addition of FeCl to thermophilic process
SAR	~2-3	Per thermophilic lab results
aluminum	30-60 mg/kg (ppm)	Per lab results
zinc	18 mg/kg	Per mesophilic lab results because of potential for polymer addition to contain zinc
copper	4 mg/kg	Per mesophilic lab results because of potential for polymer addition to contain zinc
boron	4 mg/kg	Per mesophilic lab results because of potential for polymer addition to contain zinc
Na - sodium	0.10%	Per lab results
sulfur	>200 - 2000 mg/kg	Per lab results

### 3.4.3 Pathogen Content

It is generally claimed and widely documented in the literature that the thermophilic process results in greater pathogen reduction than the mesophilic process (Sahlstrom, 2002; Olsen, 1985; Watanabe, 1997). The results of the biological analyses performed for this study were inconclusive on this issue. The analysis used a membrane filter screening technique rather than the EPA method for fecal coliform. E. coli were detected at 26 Most Probable Number (MPN) for the thermophilic sample and 2300 MPN for the mesophilic sample. WAC 173-350-220 requires less than 1000 MPN for fecal coliform of which E. coli is one type.

Total coliforms were detected at 2300 MPN for the mesophilic sample, but at 6150 MPN for the thermophilic sample. Fecal coliforms are a subset of total coliforms. It is not understood how this bacteria count could be so much higher than that of the mesophilic sample. Possible explanations include: the presence of thermophilic coliforms involved in the process of breaking down the material in the digester; re-growth of bacteria between sampling and analysis; contamination of the sample prior to analysis. It is not known if the coliforms reported as “Total Coliforms” are pathogenic or not. The total bacteria count for the thermophilic sample is less than that of the mesophilic sample (499 µg/gdw<sup>8</sup> versus 886 µg/gdw).

#### **3.4.4 Chemical Characteristics and Contaminants**

Potential contaminants in a manure based, anaerobic digested solid include chemicals originating in the feedstocks and chemicals added during the process. Chemicals originating in the feedstock could include copper sulfate from footwash, antibiotics, pesticides or herbicides used on feed crops, or other chemicals encountered by the animals or bedding. Chemicals added during the processing could include polymers to aid in thickening the solids, chemicals added to the process to prevent volatilization, petroleum products or hydraulic fluids from equipment or leaking machinery, or contamination from previous use of trucks used for transport.

Elemental differences in the analyses between the thermophilic and mesophilic samples, besides nutrients included the concentration of iron, sulfur, aluminum and chloride. High iron, sulfur and chloride concentrations in the thermophilic results were likely due to sulfides being immobilized during digestion by addition of FeCl. The sulfur was not artificially added as far as is known unless it was in the polymer. So, the 2000 mg/kg concentration likely represents sulfur originally in the feedstocks. This amount of sulfur was not found in the mesophilic sample because at the Cal-Gon facility sulfides were captured during purification of the gas. It is not known what was done with the removed sulfur products.

☞ Reference to sulfur or sulfides treatment were not found in the FS and may need to be considered.

Aluminum was higher in the mesophilic sample than in the thermophilic sample. The mesophilic plant reportedly uses no additional chemicals, so this difference may be due to a difference in feedstock.

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<sup>8</sup> micrograms per gram dry weight



## 4 Market Analysis

### 4.1 Approach

The solids characteristics determined in Section 3 were used to assess the most suitable market and to contact representatives of that market. Businesses in that market were studied. Contacts with potential larger users were made to establish their cost tolerance for similar materials along with advantages and disadvantages for this product and other defined potential products from this project.

Most of the markets investigated price by the cubic yard. As indicated in Section 3 the bulk density of the material at 25% solids is on the order of 1000 pounds per cubic yard.

### 4.2 Most Probable Market & Price

Potential markets investigated included topsoil blending, nursery greenhouse operations, turf top-dressing, peat replacement, compost replacement, WSDOT erosion control, and residential sales. The location of this project is fortuitous for the marketing of these organic products. The local King County market will fetch a significantly higher price for this type of soil amendment than areas immediately outside the metropolitan region. Outside this area<sup>9</sup> contacts indicated a ready availability of manure products and much lower price potential.

✎ The most likely market for the material “as-is” without any additional processing (72% moisture before composting/biodrying, and odorous), compares with the sawdust and raw manure market. This market is very low value on the order of \$3 per cubic yard (\$4 per ton).

Once the assumption of a further processing step (such as composting) is made, a number of other markets open up. The compost market prices range from \$9 per load (due to an over abundance of supply at this time)<sup>10</sup> to \$27.45 per cubic yard retail.<sup>11</sup> There is apparently an oversupply on the market at this time witnessed by a \$2 per cubic yard discount being offered by Cedar Grove.<sup>12</sup>

The highest value market for this product appears to be as top dressing in the residential marketplace replacing the expensive peat moss applications currently used. This is also where the bagged product may fetch the greatest sales.

The highest value markets for the bulk material are both the residential and the nursery greenhouse usage in improving root stock development. Uses of the digested material as 10-25%<sup>13</sup> of a mix seem to be what the industry agrees on and would be greatly interested in. A growth study at the University of Washington sponsored by the City of Seattle is reported to show percentages of anaerobic digestion residual as high as 40% in a potting mix produced superior plant growth

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<sup>9</sup> CWMC; telephone interview; Skagit Valley Nursery; October, 2003; Mount Vernon, WA.

<sup>10</sup> CWMC; telephone interview; Pacific Topsoil; October, 2003; Mill Creek, WA.

<sup>11</sup> CWMC; telephone interview; Sawdust Supply; October, 2003, Seattle, WA.

<sup>12</sup> <http://www.cedar-grove.com/fallpromo.htm>; Accessed 10-14-03. Currently asking \$16 per cubic yard picked up.

<sup>13</sup> This could be higher if salts were lowered in the product.

results.<sup>14</sup> Nursery personnel interviews indicated that \$10 to \$12 per cubic yard (delivered) would be comparable with other similar materials (See Appendix D for notes from interviews).

Based on the information gathered in the market study the FS assumption of \$20 per ton (\$10 per cubic yard) should eventually be reasonable. As a baseline, between 7,000 and 10,000 cubic yards per year of this product may feasibly be sold at this price, eventually.

There are some important cautions to bear in mind before counting on that price for that quantity of material:

- 1) This is a new product that nurserymen and consumers are not familiar with. It will require active, creative marketing, extensive analysis and material given away for growth trials and customer good will to build confidence that the material will perform well. Especially for the nursery industry, a minimum of a year's worth of trial data and name brand building should be expected before any significant sales are made to this group.
- 2) The anaerobic digestion as well as composting (or other processing) operations will both need to be started up and stabilized so that the residual solids produced are of a consistently high quality.
- 3) The average unit value of the solids will begin low and gradually rise over time. The yard waste composting experience in the King County area can help reveal how the relative pricing changes over time. When the program began in 1989, compost had a retail price of about \$7.50 per CY (about \$13.50 per ton). The overall pricing was considerably lower when considering retail, wholesale, and promotion (no charge) deliveries. The blended unit price at one large producer was closer to \$7.00 to \$9.00 per ton<sup>15</sup>. Over the fourteen years the program has been in existence the blended price for retail, wholesale, and promotion deliveries has risen to \$17.50 to \$26.00 per ton<sup>16</sup>. The marketing efforts associated with this included advertising, public education campaigns, delivery services, sales staffing, and sponsoring product quality research.
- 4) At higher prices the amount able to be sold may drop off significantly in the early years. \$10 per cubic yard is the most optimistic threshold of the product value initially until it establishes a name and a track record and assuming the material will be composted and actively marketed. This does not include contingency for typical startup difficulties with quality and consistency. Consistency and longevity of the product in the market place (staying in business and generating repeat sales) are also big factors for market price and should be viewed as serious issues and concerns.

➤ For these reasons, we recommend planning be based on \$10 per ton initially, ramping up to \$20 per ton within 5 years.

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<sup>14</sup> Allen, Jan; CH2M HILL; October, 2003.

<sup>15</sup> Cedar Grove Composting; past price lists; King County, Washington; 1989 - 2003

<sup>16</sup> *ibid*

### **4.3 Factors Affecting Product Value**

#### **4.3.1 Composting and Organic Certification**

It becomes quickly obvious that the market price for the solid residual immediately off of the solids separator would be very low. Composting the product and obtaining organic certification<sup>17</sup> are the two factors that will most readily increase the market and market price of the material. Composting would also open the product for WSDOT approval which is a very large, if lower value market. Additionally, marketing and advertising will be key to obtaining the maximum value for the product. Bagging and labeling will also increase the range, market, and price that could be obtained for this material.

Indication from literature and the FS that pathogen reduction would be much higher at thermophilic temperatures than at mesophilic temperatures is not questioned in this study. However, the market does not use that criteria per se to value the product.

To gain access to the organic producers market, build credibility, and the ability to ask the best price for the product organic certification for it is important. There are several categories for compost and manure based materials under the National Organic Program (NOP). Appendix E presents the NOP requirements and WSDA requirements<sup>18</sup> for this type of material. To obtain certification as a “processed manure”<sup>19</sup> under the NOP requires a pasteurization step of 150°F for at least one hour, and drying to 12% moisture or less. Those criteria are the same whether the process was mesophilic or thermophilic, unless it is composted. If composting is used as a post-processing step, again, it would not matter whether the material had undergone mesophilic or thermophilic anaerobic digestion prior to that step. Composting regulations require permitting, and meeting the processes established under WAC 173-350-220 for pathogen reduction, stability, testing, etc. Another advantage of composting is that it makes the material available for use under WSDOT specifications. This is a selling point for topsoil blenders, but is a lower price market. The decision, therefore, to use mesophilic or thermophilic digestion temperatures should be made based on other criteria than solids marketing.

✎ The FS implied that organic certification would be available for this product without further processing. This is accurate only if the product were certified in the “raw manure” category which carries with it restrictions on use including time that must be between application and planting and harvesting certain types of crops. The raw manure category is a very low value category and will not fetch the \$20 per ton assumed elsewhere in the FS.

#### **4.3.2 Moisture Content and Total Quantity Available for Sale**

Composting and accompanying organic breakdown and drying will reduce the quantity of material generated from the process per year. This evaluation estimates 36,000 tons will reduce to about 18,000 tons of salable high-quality product at 60% total solids. This would reduce the amount available for sale. Exhibit 7 in the FS indicated capacity for 100-days storage (3 piles @ ~100'x~150' for 5000 cubic yard per month or approximately 1.4 acres). This should be adequate

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<sup>17</sup> Certification for use in producing organic food

<sup>18</sup> Provided by Miles McEvoy, WSDA, 10-13-03.

<sup>19</sup> The FS states that the material can be certified organic without additional processing. While this is true, that certification category is as a “raw manure” which carries with it waiting times between application and planting and other restrictions. This certification would not increase the cost that could be asked for the product significantly over the \$3-\$5 per cubic yard that could be obtained on the raw manure and sawdust market.

for composting and would resolve issues about pathogens, open the market to DOT uses, as well as satisfy most of the organic standards requirements for an “aerobically digested compost” category.

#### **4.3.3 Marketing**

An active sales and marketing effort will be necessary to realize the required income for the solids (and liquids) from this proposed project. In King County virtually every soil and organic amendment producer has a sales staff, offers multiple products, attends education events, participates in promotional recycling and gardening events, and offers delivery services. One large producer offers 14 soil mixes, 7 mulches, and 2 kinds of peat (all in bulk).<sup>20</sup> Only one local producer contracts the sales activity to others, and they still maintain a marketing effort to support their re-sellers.<sup>21</sup>

Another key success factor in creating and maintaining a market for these solids that the market team should take on would involve maintaining close coordination with local government waste planners and academic institutions. The King County waste planning and recycling agencies have sponsored research and produced numerous third-party reports that have helped build demand for recycled organic materials. This success is perhaps more pronounced in King County than most other regions of the United States. It began in the late 1980s and continues to grow today. Water agencies have stepped into these issues as well as a way to minimize landscape chemical use (runoff control through the use of soil amendments) and irrigation water in the summer months (water conservation through the use of soil amendments). These activities are important in expanding and maintaining the market for organics in general. Marketers of this product should recognize that the current demand for these products is partially sustained by public agency spending on product research, education, and promotion.

#### **4.3.4 Bagging**

Bagged products bring dramatically higher per yard prices than bulk products – ranges for boutique composts were found between \$50 and \$108 per cubic yard<sup>22</sup> retail depending upon the material. However, there are a number of drawbacks. The market may be overall smaller. The product should be well known and of recognized high value before attempting bagged sales or the distributors will sell the products at too low a price to move them. Added transportation cost, capital cost of equipment and operating expenses of bagging, and cost of distributing all keep profit from the producer. The moisture content of the material will need to be much lower than for bulk sales which would further reduce the volume of material available for sale. Moisture content for bagging should be on the order of that required for organic processed manure certification.

#### **4.3.5 Consistent Quality**

The companies contacted during the market study were interested only IF the material proved to be of consistent high quality proved by growth trials on specific horticultural crops, and acceptable chemical and microbial testing. Factors that could decrease the required quality include: use of polymers in the process that may increase salts and impede organic certification; use of copper sulfate foot baths by dairies could increase copper in solids which can be toxic to plants and could upset microbial activity in the digester; detection of high levels of residual herbicides or pesticides such as clopyralid or picloram.

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<sup>20</sup> <http://www.pacifictopsoils.com>

<sup>21</sup> [http://www.lrilandfill.com/compost\\_factory.asp](http://www.lrilandfill.com/compost_factory.asp)

<sup>22</sup> Terre-Source<sub>LLC</sub>; telephone interview; Cottage Creek Garden Center; October, 2003; Woodinville, WA.

On the positive side, professional landscapers and wholesale buyers periodically find deficiencies in the compost and organic amendments currently in the local market. If this product could be produced very consistently and of high quality, there is room potentially higher pricing over time. In 2000, King County commissioned a study of current practices and attitudes about compost use in King County. The twenty participants identified the key quality problems where improvement could be made included; "hot" or immature product, anaerobic or odorous product, excessive moisture content, inconsistent texture and clumping, and presence of weed seeds<sup>23</sup>. All of these items could likely be addressed with careful post-processing of the anaerobic residuals from this project.

#### **4.4 Other Examples of Marketed AD Solids**

Although there are a fair amount of anaerobic digesters in the country relatively few are selling their residual. Those that are selling the product are spending energy and costs to further prepare the product for a market. EPA's AgStar<sup>24</sup> program published profiles of 24 AgStar anaerobic digesters in 2003. Of these 24 only six reported selling some of their product; five used all or some of their product for animal bedding; the remainder land applied the effluent and solids. Of the six who sold their product at least two composted and one pelletized the product and marketed it as an organic fertilizer or soil amendment. There was no information about processing for the other four and no mention of price for any of them.

In a recent article in BioCycle magazine Jerome Goldstein discussed the state of the Biogas industry and made no mention of marketing the solids residual. He mentioned that solids were being "land applied for fertilizer value", that operating costs included "waste hauling" and that "Farmers will gain the fertilizer value of the treated wastes".

There are a few. Locally, the Cal-Gon Farm operation and the now-defunct Craven Farms in Oregon have sold their residual solids. PGE sells the residual from Cal-Gon Farms to Pro-Gro for \$3.00/cubic yard picked up at the farm; while Craven Farms got \$7-8.00 a cubic yard to deliver it to Pro-Gro, a wholesaler of soil products.

The market price discussed above assumes an actively marketed, composted product. However, due to the lack of evidence that a similar operation has been able to market their material this remains only prediction.

#### **4.5 Marketing**

To market this material at or near the FS assumed value of \$20 per ton, further processing will be required, and a sales and marketing program must be added to the business model. In addition, there is a need for winter storage of the product since the market demand also decreases in the winter. The FS includes reference to 100 days storage. This provides enough time to compost and cure the material. It is not enough time for seasonal winter storage.

✎ The material may have intrinsic nutrient value, however, if users are able to obtain similar materials at lower cost or free there is no market. To develop a market requires time, effort and cost, but could be worth it for the return on investment. Assumptions in the FS for Operating

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<sup>23</sup> King County Department of Natural Resources; Landscaper Focus Group Findings - Current Practices and Attitudes about Compost Use in King County; December, 2000; King County, Washington

<sup>24</sup> <http://www.epa.gov/agstar/library/handbook/appendixa.pdf>

Costs should be adjusted to include composting, permitting and laboratory analyses, organic certification, sales services, winter storage, and marketing.

- Based on the current market conditions, the expectation should not be to sell all of the material produced. The market does not currently exist for this product and will have to be developed. Active marketing may result in sales of up to 15,000 cubic yard per year.<sup>25</sup> Additionally, there will be some quantity required to donate, especially initially, as a sales tool, to build customer confidence, and for community relations. Jack Hoeck of Rexius<sup>26</sup> estimates this to be approximately 1% for that operation.

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<sup>25</sup> Terre-SourceLLC; telephone download from CWMC of estimate of market for this material after completion of market study; October, 2003.

<sup>26</sup> CWMC: telephone interview with Jack Hoeck/Rexius; October 2003;

## **5 Conclusions**

### **5.1 Summary of Variance with FS Assumptions**

Issues related to the production and marketing of the solids as soil amendment that were found to vary from assumptions made in the FS were:

- ✎ Solids handling equipment was not described in detail in the FS. It is not known whether the \$1.2 million figure includes items such as a medium sized front end loader, a dewatering device, a trash screen, a biodrying (composting and drying simultaneously using forced air) system.
- ✎ The FS assumes \$5 per ton for solids residual handling. Given the need for composting of the residuals this number is low based on other similar operations. An example of a similar operation was found to be \$10 to \$15 per ton.
- ✎ The need for 6 to 9 months of seasonal storage of product is estimated to require approximately 2 acres of space either at the plant site or elsewhere. If elsewhere, transportation costs need to be included.
- ✎ A 3 to 5 year ramp up (discount) period may be necessary before the product market price is able to reach its average market value.
- ✎ The need for marketing staff and activities to get product accepted and valued in the market should be included in the operations cost for this project.
- ✎ If composting is used to polish the residual solids for preparation for a higher value market the volume of the material available for sales will reduce due to further solids degradation and moisture loss (from 37,000 tons assumed in the FS, to approximately 18,000 tons after composting and reduction to 55% solids). The FS assumed 37,000 tons in its Proforma income category. This should be adjusted to reflect the quantity of product available after shrinkage.
- ✎ The potential for the material produced to exhibit a strong odor was reported by two sources in this study. The FS stated that the material emitted would have no odor.
- ✎ Two facilities contacted during this study reported measures that had to be taken to deal with production of sulfides during digestion. There is no mention of sulfur or sulfides in the FS, but this may be an area that will have to be addressed.
- ✎ The market study resulted in indication that the most probable market for the residual material “as-is” without further processing was that of raw manure and sawdust at a market price on the order of \$3 per cubic yard (\$4 per ton).
- ✎ Although the market analysis indicated that there is demand for a high quality product similar to that expected from this project (after composting, biodrying, and obtaining organic certification), there may be a good deal of effort and time required in order to count on this market and to create a market large enough to consume all of the material produced. Therefore, we recommend that planning for the project be conservatively based on \$10 per ton initially, ramping up to \$20 per ton or higher within 5 years.

- ✎ The FS implied that organic certification would be available for this product without further processing. This is accurate only if the product were certified in the “raw manure” category which carries with it restrictions on use including time that must be between application and planting and harvesting certain types of crops. The raw manure category is a very low value category and will not fetch the \$20 per ton assumed elsewhere in the FS.
- ✎ Assumptions in the FS for Operating Costs should be adjusted to include composting, permitting and laboratory analyses, organic certification, sales services, winter storage, and marketing.
- ✎ The FS should reduce the quantity of material available for sale by about 1% to account for donations of material as a sales tool, to build customer confidence, and for community relations.

## **5.2 Suggestions for further research**

This study found that a further processing step would be needed to make the anaerobic digestion residuals into an accepted, stable, high quality product that could draw a high market price. Composting was recommended as the most appropriate process to achieve those goals. The digested residuals, however, have already been degraded to approximately 50% of their volatile solids content.<sup>27</sup> Further study should be performed on the performance of these residuals during composting to ensure that the required temperatures<sup>28</sup> can be met without adding additional materials for energy.

A quality that comes up in nearly every consumer market study for compost materials is consistency. Although the process and feedstock for the proposed AD project are much more consistent than many compost facilities, the actual variability in solids characteristics is not known. A literature study should be performed to determine if there is any long term, or at least seasonal data on these types of materials (both anaerobic digestion materials and dairy solids). If a pilot study is performed using Enumclaw dairy solids input, we recommend doing frequent periodic testing over the period of at least 1 year to determine this variability. Alternatively, perhaps another dairy manure anaerobic digester could be contacted and its input and output tested over the course of a year to give an idea of that variability.

One red flag in the chemical analyses of both mesophilic and thermophilic residual samples was that of high salts. This can be a critical parameter for some crops and limited the amount of product that could be used by nurseries and greenhouses. It is not currently known why some anaerobic digested solids contain high salts and some do not. Investigation into that question would be warranted given the importance of producing a high quality residual product and opening up all potential markets.

Given that ferric chloride was added to the digester and affected the quality of the resultant solids it would be prudent to investigate other facilities and the potential for high sulfides production in any system selected for use for this project. Addition of chemicals to the process could impact the ability to have the residual certified as organic. The investigation should include alternative ways to deal with sulfides formed during the digestion.

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<sup>27</sup> Burt Tribble; report during stakeholders meeting in Renton, WA; 9-30-03.

<sup>28</sup> WAC 173-350-220 requires a Process to Further Reduce Pathogens (PFRP) which depend upon the composting system used. For an aerated static pile system the requirement is 131°F for 3-days)



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## **Appendices**

Appendix A: Anaerobic Digester Operations & Solids Characteristics Table

Appendix B: Laboratory Data

Appendix C: Growth Trial Data and Photos

Appendix D: Notes from Market Contacts

Appendix E: National Organic Program and WSDA Organic Certification Information

**Appendix A**  
**Anaerobic Digester Operations & Solids Characteristics Table**



## **Appendix B Laboratory Data**

October 3, 2003

WALLACE LABS		MEDIA REPORT	
365 Coral Circle		Location Terre-Source LLC	
El Segundo, CA 90245		Requester Tami Thomas	
(310) 615-0116		graphic interpretation: * very low, ** low, *** moderate	
ammonium bicarbonate/DTPA extractable - mg/kg soil		**** high, ***** very high	
Interpretation of data		Sample ID	03-275-08
low medium high		Number	03-275-09
0 - 12 16 - 28 32 - 44		Thermophilic Sample	Mesophilic Sample
0-240 240-500 500-700		graphic	graphic
0- 12 12- 20 over 20		phosphorus	787.59 *****
0- 2 3 - 4 over 5		potassium	5,234.79 *****
0- 4 4 - 6 over 6		iron	1,837.84 *****
0- 0.5 0.6 - 1 over 1		manganese	65.13 *****
0- 1 1 - 2 over 2		zinc	41.64 *****
ratio of calcium to magnesium		copper	9.21 *****
needs to be more than 2 or 3		boron	9.16 *****
should be less than potassium		calcium	2,411.67 *****
		magnesium	2,339.15 *****
		sodium	1,082.07 ****
		sulfur	2,168.06 ****
		molybdenum	2.03 ****
		aluminum	32.13 ****
		arsenic	nd *
		barium	0.30 *
		cadmium	nd *
		chromium	nd *
		cobalt	0.44 *
		lead	1.80 *
		lithium	1.69 *
		mercury	nd *
		nickel	1.41 *
		selenium	nd *
		silver	nd *
		strontium	12.20 *
		tin	0.49 *
		vanadium	1.48 *
		Saturation Extract	
		pH value	8.21 ****
		ECe (milli-mho/cm)	4.68 *****
			millieq/l
		calcium	42.4 2.1
		magnesium	79.6 6.6
		sodium	114.9 5.0
		ammonium as N	323.0 23.1
		potassium	554.9 14.2
		cation sum	51.0 27.3
		chloride	461 13.0
		nitrate as N	0.5 0.0
		phosphorus as P	14.9 0.5
		sulfate as S	286.9 17.9
		anion sum	31.4 3.5
		boron as B	0.99 ****
		SAR	2.4 **
		exchangeable ammonium as nitrogen	12,920 6,192
		est. gypsum requirement-lbs./cubic yard	61 42
		Total Nitrogen	2.58% bulk density
		Total Carbon	41.12% pounds/cu ft
		Carbon:Nitrogen Ratio	16.0 39.3
		lime (calcium carbonate)	yes
		organic matter	78%
		moisture content of media	291.7%
		half saturation percentage	436.2%

Elements are expressed as mg/kg dry soil or mg/l for saturation extract.  
pH and ECe are measured in a saturation paste/extract. nd means not detected.

**7 Compost Feedstock Analysis**

Assay	Active Fungi	Active Bacteria	Total Fungi	Fungal Dia. (um)	Total Bacteria															
Desired Range Compost Feed.	0–10+ug/gdw	10–150+ug/gdw	0–20+ug/gdw		0–300+ug/gdw															
Sample # 0178 Tammy, fresh similar to #0179	NR	NR	17	2.5	499															
0179 Fresh Digested Fiber, 105F	0	76	23	2.5	886															
0180 Semi Aged Fiber, 2-3 wks old,105F	25	0	135	2.5	1037															
0181 Well Aged Fiber 2 mos. old 105F	7	4	83	2.5	296															
Comments:	<p>Summary: Samples #0180 and 0181 have a good level of active fungal biomass, which will aide in the decomposition of the complex carbon sources of this feedstock and other feedstock if these products are to be used to make compost.</p> <p><b>Fecal Coliform Analysis*</b></p> <table><tr><td>Sample#</td><td>MPN Total Coliform</td><td>MPN E. coli</td></tr><tr><td>0178</td><td>6150</td><td>26</td></tr><tr><td>0179</td><td>2300</td><td>2300</td></tr><tr><td>0180</td><td>1500</td><td>1500</td></tr><tr><td>0181</td><td>3200</td><td>31</td></tr></table> <p>*Preliminary Research data has indicated that in addition to temperature assessment of nutrient and microbiological content of feedstock for compost and potting mixes is needed to ensure pathogen reduction. Preliminary Research data collected by MMSI indicates that chemical or nutrient changes in a feedstock or compost may encourage the growth of Pathogens such as E.coli. Initial data being reported is that levels low levels (&lt; 30mg/kg) of SO4 are associated with a reduction of E.coli. Also low levels of Active Microbial biomass (&lt;14ug/gdw) are as associated with a reduction of pathogens.</p> <p>In other words changes in the nutrient makeup of a feedstock, compost or compost tea may be linked to pathogen reduction. The active microbial population regulates these nutrient changes. Both samples 179 and 181 have Active microbial biomass greater &gt; 14ug/gdw and have higher levels of E. coli. Check chemical data analysis on digested fiber and make note of nutrient content. The level of SO4 could be different for this particular feedstock. The preliminary data above are from compost and compost tea chemical Analysis. The nutrient levels associated with pathogen reduction maybe different for this type of a product.</p>					Sample#	MPN Total Coliform	MPN E. coli	0178	6150	26	0179	2300	2300	0180	1500	1500	0181	3200	31
Sample#	MPN Total Coliform	MPN E. coli																		
0178	6150	26																		
0179	2300	2300																		
0180	1500	1500																		
0181	3200	31																		

Ratios	Total Fungi: Total Bacteria	ActiveFungi: Total Fungi	Active Bacteria: Total Bacteria	Active Fungi:Active Bacteria	Gram Dry Wt.
Sample # 0178  Tammy,thermo	0.034	-	-	-	.26
0179 Fresh Digested Fiber, meso	0.026	0	0.086	0	.29
0180 Semi Aged Fiber	0.131	0.186	-	-	.27
0181 Well Aged Fiber	0.282	0.079	0.015	1.53	.89
Comments: Description of Project.  Treatments and Replicates	<p>Total Fungi:Total Bacteria Ratio = Ratios &gt; 1; System is dominated by Fungi. Ratios &lt; 1; System is dominated by bacteria. Ratio = 0.5 has a good balance of Fungi and Bacteria.</p> <p>Active Fungi:Total Fungi = Ratios &gt; .10; feedstock is well aged and will enhance the rate of decomposition. Feedstock would be ideal for use with compost piles starting at a C:N ratio of 40:1 and may comprise at least 40% of initial compost pile. Feedstock with ratios &lt; .10 should be used with compost piles starting with a C:N ratio of 30:1 and may comprise at least 35% of initial compost pile. New compost piles comprised of feedstock with ratios &lt; .10 must be properly watered and turned often to reach maturity and stability.</p> <p>Active Bacteria:Total Bacteria = Ratios &gt; .10; is well aged and will enhance the rate of decomposition. New compost piles comprised of feedstock with ratios &lt; .10 may take longer to reach maturity and must be properly watered and turned often.</p> <p>Active Fungi:Active Bacteria = Ratios &lt; .10; feedstock would be ideal to make a general all purpose compost that will have a good balance of fungi and bacteria. Feedstock with ratios &gt; .10 may result in a finished compost product that would be dominated by fungi.</p> <p>Summary: These samples of digested fiber would be ideal as feedstock for compost. Sample #0181 would be the most ideal. Adding these sources into a potting mix blend may not be ideal from a microorganism point of view. Activity levels would be too high and tie up needed nutrients. Further aging or compost may make Sample #0181 a useful amendment to potting mixes. However, growth trials and chemical analysis would be more definitive.</p>				



Assay: Protozoa	#Flagellates/mL	#Ciliates/mL	#Amoeba/mL
Desired Range for Compost Tea	1000	25-50	1000
Sample# 0178	NR	NR	NR
0179	230	2.55	21.30
0180	1,390,000	5.98	39.30
0181	41,000	11,300	77.70
	Unless you can accurately control the amount of manure that goes into the digester this number will fluctuate.	<p>This number does not reflect that Sample #0181 is anaerobic.</p> <p>The high ciliate count in Sample 0181 may indicate that a difference in the management of the final product.</p> <p>Was the product simply stored and aged? Was there some process digestion that could have influenced this high ciliate count?</p>	Manure based feedstock or compost like products will predominately more flagellates than amoeba.

## Appendix C

### Growth Trial Data and Photos

<b>Table C-1 – Radish Seed Germination Data</b>							
Radish Trial - Planted: 30-Sep-03							
5 seeds per pot							
Numbers in tables are number of seeds sprouted							
Radish - Oct 2, 2003							
	Compost	Humus	Peat	Thermo	Meso	Sandy-loam	
100%	0	3	1	0	0	1	
75%	1	2	1	1	1	x	
50%	0	1	0	1	1	x	
33%	2	0	4	0	0	x	
25%	2	0	2	0	1	x	
15%	1	0	3	0	0	x	
Radish - Oct 3, 2003							
	Compost	Humus	Peat	Thermo	Meso	Sandy-loam	<u><b>watered</b></u>
100%	2	5	5	0	0	3	Pt, Ms
75%	2	4	4	2	1	x	Pt, Ms
50%	4	3	1	3	3	x	Pt, Ms
33%	3	1	4	3	3	x	Pt, Ms, Hm
25%	2	3	2	4	2	x	Pt, Ms, Hm
15%	2	5	3	3	3	x	Pt, Ms, Hm
Radish - Oct 4, 2003							
	Compost	Humus	Peat	Thermo	Meso	Sandy-loam	
100%	4	5	5	0	0	5	
75%	5	4	4	4	5	x	
50%	5	3	1	4	5	x	
33%	4	2	5	5	4	x	
25%	3	5	4	5	5	x	
15%	4	5	3	3	5	x	
Radish - Oct 5, 2003							
	Compost	Humus	Peat	Thermo	Meso	Sandy-loam	
100%	5	5	5	0	1	5	
75%	5	5	5	4	5	x	
50%	5	3	1	5	4	x	
33%	4	4	5	5	5	x	
25%	3	5	4	5	5	x	
15%	4	5	4	4	5	x	

Radish - Oct 6, 2003 – Last Day							
	Compost	Humus	Peat	Thermo	Meso	Sandy-loam	<i>watered</i>
100%	5	5	5	0	1	5	<i>all</i>
75%	5	5	5	4	5	x	<i>all</i>
50%	5	3	1	5	4	x	<i>all</i>
33%	4	5	5	5	5	x	<i>all</i>
25%	3	5	4	5	5	x	<i>all</i>
15%	4	5	4	4	5	x	<i>all</i>
Total Number Germinated on last day at all concentrations:							
	26	28	24	23	25		

**Table C-2 – Bean Seed Germination Data**

Bean Trial - Planted: 30-Sep-03

3 seeds per pot

Numbers in tables are number of seeds sprouted

Beans - Oct 4, 2003						
	Compost	Humus	Thermo	Meso	Sandy-loam	Peat
100%	0	0	0	0	0	0
75%	0	0	0	0	x	x
50%	1	0	0	1	x	x
33%	1	0	0	2	x	x
25%	1	0	1	2	x	x
15%	1	1	1	0	x	x
beans - Oct 5, 2003						
	Compost	Humus	Thermo	Meso	Sandy-loam	Peat
100%	0	0	0	0	2	2
75%	1	0	1	2	x	x
50%	2	2	2	2	x	x
33%	3	1	2	3	x	x
25%	2	2	3	2	x	x
15%	2	3	2	2	x	x
Beans - Oct 6, 2003						
	Compost	Humus	Thermo	Meso	Sandy-loam	Peat
100%	0	1	1	1	2	2
75%	2	2	2	3	x	x
50%	3	3	3	2	x	x
33%	3	2	3	3	x	x
25%	3	3	3	2	x	x
15%	2	3	3	2	x	x

Beans - Oct 7, 2003						
	Compost	Humus	Thermo	Meso	Sandy-loam	Peat
100%	1	1	1	2	2	2
75%	<b>3</b>	2	<b>3</b>	<b>3</b>	x	x
50%	<b>3</b>	<b>3</b>	<b>3</b>	2	x	x
33%	<b>3</b>	2	<b>3</b>	<b>3</b>	x	x
25%	<b>3</b>	<b>3</b>	<b>3</b>	2	x	x
15%	2	<b>3</b>	<b>3</b>	2	x	x
Bold text indicates all seeds have germinated in these treatments						

Table C-3 – Bean Plant Growth Data						
Bean Trial - Planted: 30-Sep-03						
3 seeds per pot						
Numbers in tables are height of tallest plant / Average height						
		Top Ht / Avg Ht				
Beans - Oct 6, 2003						
	Compost	Humus	Thermo	Meso	Sandy-loam	Peat
100%	0	0	0	0	2/1.5	1.5/0.75
75%	1.0 / 0.5	0.5 / 0.25	1.0 / 0.5	4.0 / 2.5	x	x
50%	2.5 / 1.75	1.5 / 0.75	2.0 / 0.75	2.5 / 1.0	x	x
33%	4.5 / 4.0	3.25 / 1.25	2.5 / 1.75	3.0 / 3.0	x	x
25%	4.0 / 3.0	3.25 / 2.25	3.5 / 2.25	3.5 / 2.25	x	x
15%	4.5 / 2.0	5.0 / 3.75	4.0 / 2.25	4.0 / 2.25	x	x
Beans - Oct 7, 2003						
	Compost	Humus	Thermo	Meso	Sandy-loam	Peat
100%	0.25 / 0	0.25 / 0	0.25 / 0	0.25 / 0.1	4.75/3.0	3.5/2.0
75%	3.0 / 2.0	1.0 / 0.75	1.5 / 1	6.5 / 3.0	x	x
50%	<b>5.0 / 3.0</b>	2.5 / 2.0	4.5 / 3	<b>5.0 / 3.0</b>	x	x
33%	<b>7.0 / 7.0</b>	6.5 / 2.5	4.75 / 3	<b>6.0 / 4.0</b>	x	x
25%	<b>8.0 / 4.5</b>	6.75 / 4.25	6.0 / 3.5	<b>7.5 / 3.0</b>	x	x
15%	<b>8.0 / 3.0</b>	<b>8.0 / 4.75</b>	<b>8.0 / 5.0</b>	6.75 / 2.0	x	X
Shading indicates largest plants in that media (i.e. of the Thermophilic mixes the 15% mix performed the best)						
Bold text indicates largest plants at that concentration (i.e. at 15% of the mix the Thermophilic fiber outperformed the other materials)						

## Bean photos

## Root photos

## **Appendix D**

### **Notes from Market Contacts**

With growth trial results, chemical and microbial data in hand we began to contact 2-4 companies within each of the suppliers, end-users and manufacturers categories. The following is a point-by-point reference of these conversations:

10-8-03

Bill Richardson

Hydro-seeding and Bark, Inc.

1-800-870-0242

- compost is typically paid \$5-6 picked up
- Residential use would be main usage
- possibly increase usage by getting DOT approved

10-8-03

Theo McCullogh

206-390-8362

- Works with south sound soil
- \$8-12 cubic yard wholesale for compost
- local harvested peat is sold at wholesale prices for \$5-12 per cubic yard
- Cedar Grove compost is sold wholesale for \$10-12

10-10-03

Pacific Topsoil (Manufacturer)– spoke with Chad

Mill Creek, WA

425-337-2700

- Yard Waste, Manure and Biosolids composts are sold around \$9 per cubic yard wholesale
- They themselves would not be interested as they find the marketplace is overburdened with product, demand exceeding supply.
- Recommended use would be for soil amendment and top-dressing.
- Main competition would be Sawdust and manure as well as traditional composts
- Big selling points would be”
  - DOT approved for landscape contractors.
  - Organic Certification for end-users
  - Pricing for entire industry
- Some companies are selling composts for \$9 per load (30 yards) due to over abundance of supply versus the demand.
- They sell to the market at \$17.60 + depending on volumes
- They see the demand increasing over the next 12 months as DOT uses more compost in their contracts.

10-9-03

10-14-03

Sawdust Supply (Growco) – Curley Winebrenner

Seattle, WA

206-622-4321

- Steerco is sold at \$17.45 + per yard picked up
- Growco is sold at \$15.45 + per yard picked up
- Cedar Grove compost is resold at \$27.45 per cubic yard
- They produce two topsoil blends
  - 50% Growco and 50% sandy loam = \$21.45
  - 33% Steerco and 67% sandy loam = \$21.45
- Organic Certification will help increase the public image and marketability and improve sales to end-user
- DOT is relatively shunned in the industry because of low value and Cedar Grove having surplus has driven the value of DOT products to a minimum.
- This product should catch on very well in the industry due to its characteristics
- \$10-\$12 range is a very reasonable range to sell this product
- Competition is VERY high
- They would be interested in selling this product.
  - When they started selling Cedar Grove compost they sold 1000 yards in year 1 of selling that product.
  - They sold nearly 7000 yards last year (year 3)

10-14-03

Seattle Tilth - Lisa

Seattle, WA 98103

(206) 633-0451

Seattle Tilth is a chapter of the Washington Tilth association. They are an educational resource for their organic grower members.

- Not a lot of organic certified soil amendments available on the marketplace
- Waltz Organics sells “Organically certified compost”
- There is a rapidly growing desire in the Seattle and King County region for Organically certified products among the end-users and Organic farms.
- In the Northwest there is a rather large concentration of organic farmers
- <http://www.tilthproducers.org/directory/directory.asp> is a site showing these farms that are members of the Seattle Tilth association.

10-14-03

Julius Rosso Wholesale Nursery – Tony Rosso

Seattle, WA

206-763-1888

This Nursery also sells to the retail public

- Organic Certification will increase the value to the end-user
- Organic Certification will not increase the cost of the product, rather increase the demand for the product, which in time could relate to the cost
- Bottom line in the nursery Industry is cost: production ratio.
- \$10-12 would be comparable to other similar products in the marketplace.



- They would be more interested in growth trials than in chemical and microbial data – productivity over numbers.
- They as would most nurseries would introduce a product gradually over the course of a year into the nursery and observe the productivity and compare it with what they are currently using.
- This product would be of interest in the bagged market as an organically certified product and would be in the range of \$2 per cubic foot bag wholesale value
- Tony would recommend advertising via radio through people such as Ed Hume and Cisco and other talk show garden people on the local radio. Also getting the product talked about by the local garden writers in the local papers will also help.

10-14-03

Lawyer Nursery – Mindy

Olympia, WA

1-800-551-9875

This nursery is a bare root nursery

- General perception of “If its not broke, don’t fix it”
- “Organic Certification” is the current buzz word, but that being said it carries no or little weight among the nursery industry using chemical fertilizers
- Growth trials and in particular the root results shared were of great interest to Mindy
  - She said that is what would set this product apart from the others out there.
- Currently similar products are selling \$8-12 range
- \$10-12 range is dead on for this type of a product delivered.
- They would be open to looking at this product in the future and seeing its results in their industry.

10-14-03

Better Buys Topsoil Bark - JD

425—228-8719

They sell to higher end markets like Magnolia, Capital Hill, and Bear Creek Country club homeowners

- Bark is purchased for \$7-12 per yard
- Compost is purchased for \$12-14 per yard
- They pick materials up as they sell to be delivered in 12- 25 yard loads
- They specialize in higher quality soil amendments for higher end uses
- Mostly a small residential and small commercial service delivery company
- Is a year away from having a sales yard in Issaquah area.
- “Commercial market may be really tough” as the commercial user is looking for the name (Cedar Grove or Growco)
- “Small home Owner looks more for quality”
- They sell 2000 cubic yards or more per year of compost.
- \$10-12 is a suitable range for a quality compost-like material

10-10-03

McClain’s Soil Supply – Corkey

253-472-8285

- Quality would have to be pretty impressive at the \$10 range for them to buy at that price
- They usually get compost delivered at \$8 per yard
- Organic certification would help public image of product
- Chemically free identity would relate well with home owners
- Product originated from statement would be a necessity

10-13-03

Specialty Soils – Chuck

253-638-2272

They supply the nursery industry as well as landscapers and other end-users

- Discussed chemical attributes and feels 15-25% range would be incorporation of this product, any higher would result in Salt toxicity.
- 15000 cubic yards of peat are purchased a year and could see a digested fiber replacing as much as 15% of that volume.
- Product will be more based on environmental image – “getting manure out of the lagoons, and the lagoons out of the area”
- Is very familiar with digested fiber and very interested in talking prices once the product is ready.
- Did not have the time to discuss the comparative prices in the marketplace with me, as he had to go.

10-14-03

Swanson’s nursery – Eric

Seattle, WA

206-782-2543

Eric worked with Sky nursery recently before coming here so gave an idea of their general view as well

- Organic Certification carries huge weight in the Seattle region.
- This product should sell very well
- Sees this product as a top dressing replacement for peat moss in grass seed
- Sellers and producers would be more interested in the growth trials and root development results then certifications and even more then in chemical results data
- End users will see the Organic certification as a big selling point – especially in a bagged product.
- Having a locally developed “green” product will sell very well in the local “small” stores and garden centers (i.e. – not the Lowe's or other corporate garden centers where price is more the issue)
- Doing both bagged and bulk would be a huge benefit.
- Swanson’s only deals in bagged product, but Sky’s deals with both bagged and bulk
- \$10-12 range delivered price is a good price and should sell well in bulk
- \$2.00 - \$2.50 would be a good bagged product price in the marketplace for this product primarily as a top dressing.

10-14-03

Skagit Valley nursery – Gary Lorenz

Mount Vernon, WA

1-800-334-1719

Being outside the metro region in a more agricultural area, I talked with them to see the interest outside the Seattle marketplace.

- Pricing is too high for outside Seattle marketplace.
- Most nurseries buy pre-mixed soils and so those nurseries would not be interested in this type of a product.

## Appendix E

### **Compost, Vermicompost, Compost Tea And Processed Manure Approved For Use Under The National Organic Program**

The National Organic Program restricts the use of compost and animal manure on organic farms. The following list describes compost and animal manure that is compliant with National Organic Program.

1. Compost composed of plant material. There are no restrictions on the use of composted or uncomposted plant residues.
2. Compost approved under NOP 205.203(c). Compost feedstocks must have an initial carbon to nitrogen ratio of between 25:1 and 40:1. In-vessel or static aerated piles must be maintained at a temperature of between 131 and 170 degrees Fahrenheit for 3 days. Windrow composting systems must be maintained at a temperature of between 131 and 170 degrees Fahrenheit for 15 days and turned a minimum of 5 times.
3. Aerobically digested compost. Must meet the following criteria:
  - a) It is made from only allowed feedstock materials including manure, plant residues, food waste, food processing waste, and other natural materials,
  - b) The compost undergoes an increase in temperature to at least 131° F (55°C) and remains there for a minimum of 3 days, and
  - c) The compost pile is mixed or managed to ensure that all of the feedstock heats to the minimum temperature. The monitoring of the above parameters must be documented in the Organic System Plan (plan) submitted by the producer and verified during the site visit.
4. Vermicompost. Must meet the following criteria:
  - a) Made from only allowed feedstock materials, except for incidental residues that will not lead to contamination,
  - b) Aerobic activity is maintained by regular additions of thin layers of organic matter at 1-3 day intervals,
  - c) Moisture is maintained at 70-90%, and
  - d) Duration of vermicomposting is at least 12 months for outdoor windrows, 4 months for indoor container systems, 4 months for angled wedge systems, or 60 days for continuous flow reactors.
5. Compost tea. Compost tea that is made from approved compost is acceptable for organic crop production. The addition of sugar or molasses to compost tea is acceptable. Sugar and molasses are not of animal origin and not restricted under NOP 205.203(c)(1).
6. Processed manure. Manure that has been heated to a temperature in excess of 150° F (65°C) for one hour or more and dried to a moisture level of 12% or less, or an equivalent heating and drying process that produces a product that is negative for pathogenic contamination by salmonella and fecal coliform material is approved for organic use.
7. Raw manure. Uncomposted animal manure that does not meet the above criteria may be used in organic crop production if applied more than 90 days prior to the harvest of crops that are not in contact with the soil or more than 120 days prior to the harvest of crops that are in contact with the soil.

## **Clopyralid**

Clopyralid is a long-lasting herbicide used to control broadleaf weeds. It passes through animals and the composting process with little degradation. The fact that it doesn't break down presents a problem for compost and manure. Compost contaminated with clopyralid may harm certain types of broadleaf plants such as beans, peas, sunflowers, peppers, tomatoes and potatoes.

### **Compost registered for use in organic crop production by WSDA**

Compost that receives WSDA approval through the brand name material registration process must be clopyralid-free. Bioassays and analytical testing are required to verify that composts approved through the brand name material registration process are free of clopyralid residues.

### **Non-registered sources of compost and manure that are not on the WSDA Brand Name Materials List**

Most compost and manure available to organic producers is not registered through the WSDA brand name material registration process. Non-registered composts and manures might fail to meet the zero tolerance standard for clopyralid. Many organic producers utilize non-registered composts and manures in order to meet their soil fertility and crop nutrient needs.

Organic producers are permitted to use compost and manure from non-registered sources as long as it meets the criteria on the previous page. Non-registered compost might contain clopyralid residues. Sensitive plants (legumes, composites, nightshades) may be damaged by clopyralid contaminated compost. There will be no effect on the organic certification status for organic producers that choose to use non-registered sources of compost and manure. It is permissible for organic producers to use non-registered compost that contains clopyralid residues. Use non-registered compost at your own risk.

### **Additional Requirements for Products Containing Compost & Manure**

The Washington State Department of Agriculture (WSDA) Organic Food Program has two additional requirements for the registration of materials that contain compost, compost feedstocks, manure, mulches, yard waste, green mulch, and other materials.

- 1) The WSDA Organic Food Program is requiring testing for clopyralid and picloram herbicide residues on all products on the BNML that contain ingredients such as compost, compost feedstocks, manure, mulches, yard waste, green mulch, and other materials. Compost and manure that receives WSDA approval through the Brand Name Material Registration process must be clopyralid-free.

**Contaminated feedstocks** include (but are not limited to) hay, straw, grass clippings, yard waste, as well as animal manure, urine, and bedding. These persistent herbicides can remain in the finished compost at levels well below standard detection limits and damage plants in the Solanaceae, Leguminaceae, and Compositae families. In an effort to prevent further contamination of compost, the state Department of Agriculture (WSDA) issued an emergency rule prohibiting the use of clopyralid-containing products on turf and lawns.

**Bioassays and analytical testing** will be required to ensure that compost or manure approved through the Brand Name Material Registration process are free of residues. The tests must be done by a laboratory that has demonstrated the ability to accurately test for these herbicides to 1 ppb (also expressed as  $\mu\text{g/kg}$ ). Anatek Labs in Idaho has reliably shown the ability to test to these levels; see *Mailing the Sample* section of this document for details

**Taking the Sample:** A composite sample is a single sample composed of multiple, well-blended sub-samples uniformly distributed throughout the entire volume that, after mixing, the sample accurately represents an average value of the general mass of material. We recommend taking cup size sub-samples from 20 locations (of varying depths) of your compost pile, then thoroughly mixing these sub-samples together in a 5 gallon bucket lined with a new plastic bag or liner. Take a 1 gallon size zip lock bag and fill it with the composite (mixed) sample, double-bag with another zip lock bag and place in a cooler with blue ice (or similar material), and mail immediately as described in the section entitled *Mailing the Sample*.

**Mailing the Sample:** Anatek is one of the few laboratories in the United States that can test your sample for clopyralid and picloram residues to a Minimum Detection Limit (MDL) of 1  $\mu\text{g/kg}$  (parts per billion), the level necessary for registration on the BNML. Anatek Laboratories charges \$125.00 (last quoted price) per sample when you mention that the sample is for WSDA BNML registration. Mail your composite sample to: Anatek Labs, Inc., 1282 Alturas Drive, Moscow ID 83843. The sample(s) needs to be received by Anatek Labs no later than 5 pm on Friday; they can also be reached by phone at (208) 883-2839 or by fax at (208) 882-9246.

**Continued evaluation of the finished compost** - is needed because the feedstocks that make up compost can continually change, thus introducing the threat of herbicide contamination with every new batch of compost made. Analytical testing of each batch of compost can be cost prohibitive; therefore we recommend that you incorporate a bioassay procedure to test each batch of compost and/or feedstocks. The Washington State University Cooperative Extension Service's Website at <http://css.wsu.edu/compost/bioassay.htm> describes the procedure for setting up a bioassay testing procedure.

- 2) Products registered on the Brand Name Materials List must meet the National Organic Program requirements as outlined in the attached document entitled, *Compost, Vermicompost, Compost Tea and Processed Manure Approved For Use Under The National Organic Program*.

**Resources on the Web:**

Washington State Department of Agriculture's clopyralid information page.

WSDA Website at <http://www.wa.gov/agr/PestFert/Pesticides/Clopyralid.htm>

Anatek Laboratory's clopyralid information page.

<http://www.anateklabs.com/services/ag/clop.asp>

WSU photos of plants damaged by compost containing clopyralid.

<http://css.wsu.edu/compost/herbicide/pictures.htm>.

WSU bioassay for herbicide contamination of compost.

<http://www.puyallup.wsu.edu/soilmgmt/Clopyralid.htm>

U. S. Composting council position paper on clopyralid and composting.

<http://www.compostingcouncil.org/article.cfm?id=35>